

## Article

# Towards Integration of Climate Disaster Risk and Waste Management: A Case Study of Urban and Rural Coastal Communities in the Philippines

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**Abstract:** Coastal communities are exposed to various environmental risks, including natural hazards such as storm surges and flooding. As climate change has escalated, the management of such dangers has grown in importance and urgency, particularly among states with long coast lines. Climate change adaptation and disaster risk reduction have attracted attention from policymakers in South-east Asia, which is one of the most disaster-prone regions. Coastal community resilience, however, is not determined by climate and disaster risks alone, but by other factors as well. Waste pollution is an environmental threat that may affect those who are dependent on marine resources. These multiple factors contribute to coastal resilience and are, in fact, addressed separately as different issues; therefore, conflicts or synergies in respective countermeasures often become oversights in the policy-making processes. Through a case study of key Philippine stakeholders, including fishing communities, we identified impacts of climate change, natural hazards, and waste on the livelihoods of community residents and the interplay among these factors. We aim to better understand the situation on the ground and contribute by improving policy recommendations for coastal communities. An integrated approach to enhance coastal adaptation is critical for maximising the effectiveness of the limited resources of communities.

**Keywords:** climate change adaptation; disaster risk reduction; coastal resilience; waste management

## 1. Introduction

### 1.1. A Harmonised Approach to Climate Change, Disasters, and Waste

Natural disasters that are exaggerated by climate change have repeatedly occurred, causing physical, cultural, and economic losses and damages along coastal areas. Coastal communities are highly vulnerable to climate and disaster risks, which are some of the most urgent challenges facing islands and coastal countries. The UN's Intergovernmental Panel on Climate Change (SROCC) showing clear-cut scientific evidence regarding the severe impact of climate-related disasters on coastal regions. Over the decades, low-lying and coastal cities have been increasingly exposed to both extreme events and slow onset changes, both of which carry the potential to significantly increase the loss and damages experienced by coastal inhabitants and their livelihoods—such as fishing [1]. As concerns over natural hazards accelerate, coastal communities and developing island countries have explored ways to address their vulnerability and to protect their people and assets. In this vein, climate change adaptation and disaster risk reduction (CCA and DRR)—which have been conceptualised in several studies such as Thomalla et al. [2] and Solecki et al. [3]—have thus attracted growing attention from these actors. The goal of such adaptation is to build

adaptive capacity so as to simultaneously reduce vulnerability and build greater resilience to adverse impacts caused by climate change [4]. In addition to policy responses to coastal vulnerabilities, community-based approaches for CCA and DRR have also been applied in some coastal cities [5,6]. Understanding the factors affecting a community's vulnerabilities is a critical step in designing CCA and DRR policies. To date, academia has attempted to provide insights aimed at improving policy designs and actions aimed at improving coastal resilience. Dolan and Walker [7] presented a framework for assessing the adaptive capacity of coastal communities to climate change-related risks. Furthermore, there has also been an increasing number of qualitative studies which assess coastal vulnerability [8,9] via various approaches, and illustrate how vulnerability is determined in the context of climate change and disasters [10–12].

It has also been recognised that the vulnerabilities of individuals and communities vary due to non-climatic factors, such as due to the prevailing social and economic conditions of a group [13]. Adger [4], who provided the ground-breaking conceptual model of social vulnerability to climate change in rural coastal communities, concluded that vulnerability stems from a combination of social factors and environmental risks. Eriksen and Brown [14] argue that “sustainable adaptation” not only requires the understanding of the role played by climate change risks, but the impacts thereof in the context of other societal and environmental changes as well. However, only a handful of existing climate risk assessments have sufficiently considered the roles of mutable non-climatic factors that affect communities' vulnerabilities. Although Lung et al. [15] have addressed this concern by considering the projected transformation of forest areas (as non-climatic drivers in their climate change vulnerability assessment of Europe), few community-level observations with this same focus exist. In considering coastal climate change adaptation, an insufficient understanding of complex intersections between factors—including non-climatic factors—would lead to a situation whereby countermeasures are implemented in a fragmented manner. In other words, policy implementations—including human resources and finance allocation—are inefficient without considering the effects caused by one scale of action on another [16]. Working in silos often results in less effective policy development and actions toward climate change adaptation; thus, synchronisation of cross-cutting issues among related agencies and stakeholders is of great importance [17]. There is a similar debate in the context of environmental migration, for which multi-sectoral coordination is useful, given its multicausality [18].

The objective of this study is to provide initial on-the-ground observations to inform readers about the issues. By shedding light on the intersections between multiple societal changes through people's perceptions and experiences in coastal communities, we explore the existing interactions of waste management with climate change and natural hazards. This study is the first part of research looking into that interaction.

As a case study, we have focused on solid waste management (SWM) in selected coastal communities in the Philippines. Waste is one of the non-climatic factors that may affect the socio-ecological environment in coastal communities, and we hypothesise that it constitutes an aspect of coastal vulnerability. The motivations for this can be divided into three perspectives. First, while there are allegations that disasters are exacerbated by waste pollution within a community, only a few studies have dealt with solid waste and wastewater as risk factors. Some of the limited studies noted are those by Neuhold and Nachtnebel [19]—which assessed flood risks associated with flood-prone waste disposal in Austria—and that of Ishigaki et al. [20], who explored urban flood risk reduction through appropriate SWM. Second, integrated approaches for waste management, CCA, and DRR are to be taken to ensure sustainable development. To achieve socially and environmentally sustainable adaptation to climate change, it is imperative to integrate accumulated knowledge relative to sustainable development with the concerns of climate vulnerability [14]. Therefore, a well-established understanding of sustainable waste management could contribute to further policy development and action toward CCA and DRR. This perspective also links with the “sustainable development goals (SDGs) wedding cake” framework [21]

which illustrates that climate resilience, marine protection, and water security should play fundamental roles in achieving SDGs globally. Recently, waste pollution—and particularly plastics which end up in the ocean or rivers—has received tremendous global attention. This attention indicates the presence of emerging policy momentum toward a solution and attracts a flow of capital and intelligent resources. Understanding the intersection between waste management, CCA, and DRR is, thus, critical in maximising the effectiveness and efficiency of such resource inputs for sustainable development in coastal communities, rather than via the solving of a single issue. Third, there are some overlaps in the policy coordination processes between waste management, CCA, and DRR. In many countries, climate change issues have been tackled by environmental ministries and meteorological services, whereas disaster risk management often lies within the domain of responsibilities of the ministry of the interior, defence, or development [22]. On the other hand, waste management is one of the responsibilities under the purview of the ministry of environment in most countries. Hence, the case study on waste management, CCA, and DRR provides a good opportunity to consider the key solutions needed to achieve a harmonised sectoral policy coordination for cross-cutting issues.

Given the aforementioned perspectives, this paper looks into the interactions between CCA, DRR, and solid waste management in the context of coastal communities' vulnerability to disasters and climate change. The target sites used in the case study include both urban and rural coastal cities in the Philippines, allowing us to compare and understand the characteristics of each city, municipality, and province. The paper focuses on three questions are: (1) how climate change, natural disasters, and waste affect the livelihoods of people in coastal communities in the Philippines; (2) whether there are any synergies and offsetting interactions among DRR, CCA, and SWM at the local level; and (3) what are the community stakeholders' perceptions of these interactions? Our approach includes qualitative methods—namely, focus group discussions (FGDs) with stakeholders at the study sites. One of our main areas of interest is small-scale fishing communities, which are often cited as the most vulnerable sector [23–25]. In addition, this study aims to provide insights into improving the policies implemented by local municipalities, in their efforts toward integrated approaches for resilient coastal communities in the Philippines.

### *1.2. The Philippines—Climate Change, Disaster Risk, and Vulnerability*

Owing to its geographical features, climate change and natural disasters are significant concerns for Southeast Asian countries, with these impacts already being observable in many parts of the region. Most of all, climate and disaster hazards affect the properties and livelihoods of coastal populations. The Philippines, which is composed of more than 7100 islands and 36,289 km of coastline, is considerably exposed to climate change and natural hazards. What should be noted here is that the particular characteristics of a “coastal community” vary in the Philippines; the urban–rural disparity has been expanding. The Philippines has well-established institutional structures and policy frameworks for DRR and CCA. Significant efforts to develop knowledge and financial instruments have been made so as to strengthen the country's resilience to climate-related disasters [25]. However, efforts made to align national policy approaches have only focused on DRR; CCA and SWM were not included. Likewise, the implementation has been slow in many ways as a result of parallel strategies, tools, and reporting mechanisms. This is aggravated by the lack of capacity at the local level [26]. The urban area opening up to Manila Bay in the west and to Laguna de Bay in the southeast makes Manila and the surrounding cities particularly prone to flooding (along the southeast coast) [27]. 2011's Typhoon Nesat caused severe storm surges, flooding, and damage, entailing more than 2000 collapsed houses across the coastal areas of Metro Manila [27]. In-migration and rapid population growth are resulting in peri-urban expansion to adjacent municipalities, and to dangerous areas for habitation [28]. In consequence, a significant number of urban poor live in informal settlements. Within the metropolitan areas of the Philippines, one-fifth of informal settlers are estimated to live

in hazard-prone areas along waterways and the coastline [29]. High population density, migration pressures, and urbanisation increase the vulnerability of urban coastal cities.

Table 1 summarises the governance structure for CCA, DRR, and waste management in the Philippines. The Philippines has yet to develop a national adaptation plan; however, it has instead outlined long-term programs and strategies for adaptation via the National Climate Change Action Plan 2011–2028 (NCCAP). The NCCAP is aligned with the National Disaster Risk Reduction and Management Plan and the Philippine Development Plan (PDP). There are three national laws that govern each sector: the RA 9003 Ecological Solid Waste Management Act of 2001, the RA 10,121 National Disaster Risk Reduction and Management Act of 2010, and the RA 9729 Climate Change Adaptation Act of 2009.

**Table 1.** Governance structure matrix for disaster risk reduction (DRR), climate change adaptation (CCA), and waste management for the Philippines.

	Waste Management	Disaster Risk Reduction	Climate Change Adaptation
Legal Basis	Republic Act No. 9003, or the Ecological Solid Waste Management Act of 2000	Republic Act No. 10121, or the Philippine Disaster Risk Reduction and Management Act of 2010	Republic Act No. 9729, or the Climate Change Act of 2009
National Government Office and Inter-Agency Council	National Solid Waste Management Commission (NSWMC), Department of Environment and Natural Resources (DENR)	National Disaster Risk Reduction and Management Council, Office of Civil Defence (OCD) Secretariat, Department of National Defence	Climate Change Commission (CCC)
Local Government Office	Provincial Environment and Natural Resource Office, City/Municipal Environment and Natural Resources Office	Provincial Disaster Risk Reduction and Management Office, City/Municipal Disaster Risk Reduction and Management Office	None (only the province of Laguna has a CCA Office)
Subnational and Local Councils	Provincial Solid Waste Management Board, City/Municipal SWMB, Barangay SWM Committee	Regional, DRRM Council, Provincial DRRM Council, City/Municipal DRRMC, Barangay DRRM Committees	None

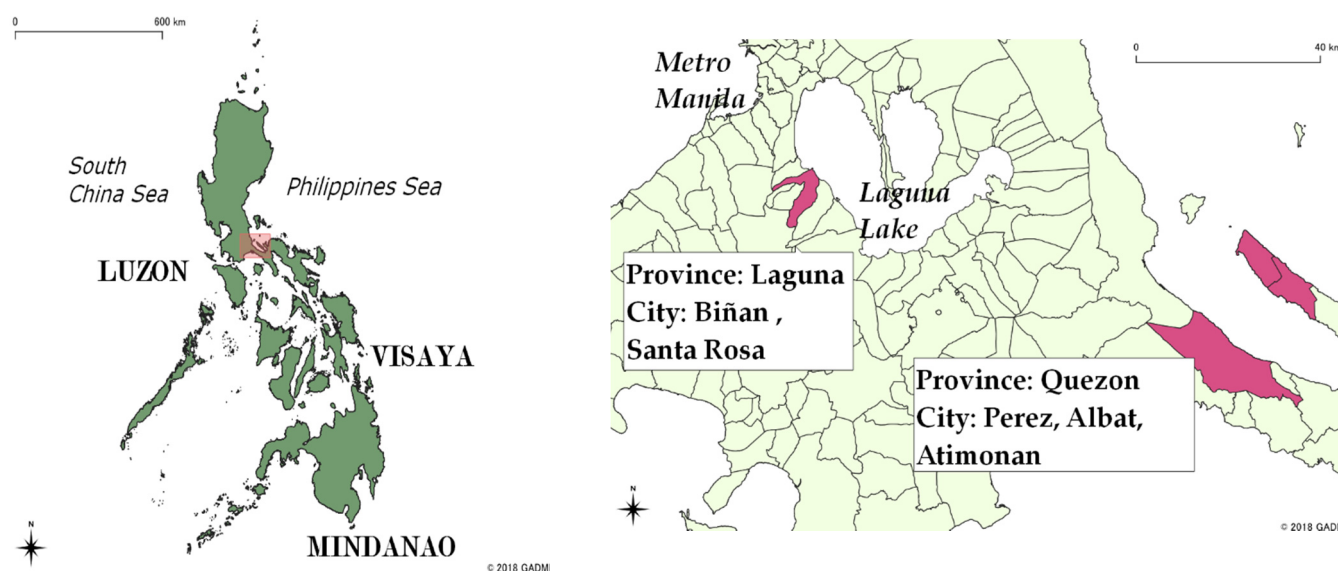
In terms of waste management, the NCCAP mentions the promotion of ecological solid waste management as a strategic action for the development of green cities and municipalities, which is one of the target outcomes set under the thematic priority of “Climate-Smart Industries and Services.” This implies that ensuring appropriate solid waste management is regarded as a key mitigation strategy for sustainable and green cities through the reduction of greenhouse gas (GHG) emissions, rather than a part of adaptation and risk management. Along with the action plan, ecological solid waste management (ESWM) programs were established and implemented in all local government units (LGUs) in accordance with the Republic Act 9003 by 2016. The Climate Adaptation Support Service (CASS) facilitates marine-protected areas and household waste management in coastal and fishing communities. Informal settlers, or those living along riverbanks and estuaries, may have solid waste management and sanitation as part of the conditionality of the CASS [30] (p. 44).

## 2. Methods

### 2.1. Study Sites

We conducted qualitative studies in two targeted areas that represent the urban and rural coastal cities and municipalities, respectively (Figure 1). The cities of Biñan and Santa

Rosa are situated in the province of Laguna, 34 km south of Manila, and face Laguna de Bay. When it comes to the rural study sites, we selected the three Municipalities of Perez, Alabat, and Atimonan—all located within the province of Quezon. These three municipalities surround Lopez Bay, a semi-closed body of water located in the northern part of Quezon.



**Figure 1.** Map of study sites, source: Database of Global Administrative Areas.

At local levels, in some cases, there are overlaps in the functions of LGUs in addressing the following three issues: climate change, disasters, and solid waste. In general, there is no local provincial-level agency for CCA, and the responsibility for CCA is usually lodged with either DRR offices or environmental natural resource (ERN) offices. The province of Laguna has an exceptional LGU office (the Laguna Climate Change Adaptation Office). This is the only Provincial CCA Office in the country. At the city level, it was found out that there is an unwritten practice that climate change mitigation is addressed by environmental natural resource (ERN) offices, which are also responsible for SWM policies, while climate change adaptation is handled by local DRRM offices. For the municipal level, there is not much clear delineation for climate change adaptation and mitigation due to the fact that the municipal DRRM officers are also designated as municipal environment and natural resource officers or planning and development officers. This is the case in the study areas in Quezon Province. The formulation of a Local Climate Change Action Plan (LCCAP) by each LGU, as mandated by the Climate Change Act, can be done by a DRRM Office, an ENR Office, or a Planning and Development Office, which may differ across cities and municipalities. This might happen because LCCAP encapsulates interchangeable components of climate change mitigation and adaptation.

## 2.2. Study Procedures

The study utilised the focus group discussions (FGDs) method to gather data from different stakeholders, with a particular focus on the interrelation between the three issues. A focus group is considered to be “a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research” [31]. FGDs could provide information about a range of ideas and sentiments that a respondent has about certain issues from the perspective of groups of individuals [32].

In this study, two different types of interviews were conducted in selected study sites, which are displayed in Table 2. A total of 61 persons finally participated in an interview. First, we conducted FGDs with local fisherfolk leaders in targeted communities. FGDs were utilized as a method of gathering data, as this provided the opportunity to gather people

from similar backgrounds—fisherfolk—to share and to discuss topics on disaster, climate change, and waste management. In the course of FGDs, participants can agree or disagree with each other, thereby providing insights on how the group thinks about certain issues on the three topics. During the FGDs the questions asked were the volumes and types of waste generated, calamities experienced in the past years, the level or preparedness, perception of climate change, and recommendations on how to improve the conditions. Examples of questions asked are:

**Table 2.** Interviews conducted in Laguna and Quezon provinces.

	Participants	Number	Venue
February 2020	Fisherfolks leaders and the City Agriculture Office	12	Biñan and Santa Rosa, Laguna
	City Government Representatives from City Agriculture, City Environment, City Environment and Natural Resource Officers and Barangays	12	
March 2020	Fisherfolks leaders	6	Perez, Quezon
	Local Government Unit Representatives from Agriculture, Disaster Risk Reduction and Management Office and Planning and Development Office	7	
	Fisherfolks leaders	12	Alabat, Quezon
	Fisherfolks leaders, Barangay Officials and Municipal Agriculture Representative	12	Atimonan, Quezon
	Total Participants	61	

“What are the specific effects of solid wastes on your fishing processes and community in general?”

“What challenges do you encounter with implementing the waste management practices that you have here?”

“How does coastal hazards and climate change affect your fishing processes and community in general?”

“Are there community-based initiatives against climate change and coastal hazards?”

The interviews with fisherfolk were supplemented through the group interviews with stakeholders who were members of local special bodies. The participants selected were members of the local special bodies representing different departments of the LGU who were the implementers of solid waste, disaster, and climate change policy in the locality. The interviews included questions about their observations of impacts of climate change, disasters, and solid waste; and existing interventions, programs, projects, and activities in the municipality to deal with these issues. Through this qualitative study, we identified the perceptions of community members and their responses for each of the three issues; and from their discussions, we gained insights into the interrelationships among the three

issues. The interviewers did not directly ask the subjects about these interrelationships, but rather asked them to discuss each issue separately in order to avoid leading questions that could have unduly influenced responses [33].

### 2.3. Socio-Economic Profile of the Urban and Rural Fisherfolk

All participating fisherfolk were male. It was interesting to note that no women engaged in fishing activities in either the urban or rural communities. The average number of years engaged in fishing activities ranged from 17 to 40 years. These fisherfolk went fishing almost every day using their “lambat” (fishing net). A number of them had their own fish pens or cages. The average daily income from fishing was approximately PHP 400.00 or (USD 8.00). During the typhoon season, it takes 3–4 days after a typhoon strike before these fisherfolk can go back and get a hold of their catch, which could reach an estimated 100 kg at PHP 50.00 per kilo (USD 1.00 per kilo). There would also usually be a surge of “bangus” (milkfish), which costs more than tilapia. This would allow the fisherfolk to earn around PHP 1000.00 (or USD 20.00) per day. The moderators were asked about the usual process of farming fingerlings. According to the fisherfolk, tilapia would usually take around a year to grow, and they would need to invest around PHP 50,000.00 (USD 1000.00). They would start organising around March and harvest during March of the following year. In other words, it will take about a year to realise the actual income for a cycle. The moderators asked the members of the group about what their alternative sources of livelihood were—aside from fishing; they mentioned that they did have other jobs—such as construction work, staffing a computer shop, driving tricycles, or making footwear.

## 3. Results

### 3.1. On Waste Management

#### 3.1.1. Waste Management in Urban Coastal Communities

In the urban fishing communities in the cities of Biñan and Santa Rosa (in the province of Laguna), fisherfolk claimed that cigarette butts, single-use plastics, sachets, plastic bottles, and diapers were the most common types of solid waste that they observed floating in Laguna Lake. Sometimes, they would take the initiative to bring this waste to shore and dispose of it in appropriate waste bins. However, the fisherfolk admitted that most of the time, they throw the waste back into the lake or simply ignore it.

The Cities of Biñan and Santa Rosa are implementing solid waste management programs and projects based on the Republic Act 9003, also known as the Ecological Solid Waste Management Act of 2000. The two cities have approved 10 year solid waste management plans via the local councils and the National Solid Waste Management Commission. However, both approved plans need to be updated, as prescribed by RA 9003. At present, both cities are focusing their efforts on programs geared towards waste reduction, waste diversion, and waste segregation. However, in both cities, solid waste segregation is not strictly observed, even though this is required by law. In addition, the “no plastic policy” has been implemented in both cities (as of 2013), albeit gradually. However, while there is a national law supported from local city ordinance, the enforcement of these policies seems to have been lenient. When asked about the effectiveness of the no-plastic policy in terms of reduction in the use of plastic bags, the concerned government officials could not provide specific data, as they had yet to conduct an assessment or monitoring of said policy. What was claimed by the local government representatives, however, is that a significant amount of single-use plastic use had been eliminated. It should also be noted that reusable plastics are allowed in cities, and the method of reduction targets the sellers and not the users.

Biñan City has a centralised facility for solid waste management with ecological gardens and brick-making equipment. The city is an awardee of the national government for environmental programs. On the other hand, the City of Santa Rosa has an environmental code (which was published in 2012). This code encompasses all the laws related to protecting the city’s environment. In the city, the use of single-used plastics and Styrofoam is not allowed. The City of Santa Rosa has also introduced a “green army,” which is tasked to over-

see the enforcement of the environmental laws, especially regarding waste management, and are in charge of penalising those who violate them. The green army also looks into establishments that are obliged to abide by the rules, and notifies the establishments that have unclean surroundings or do not practice proper waste segregation. The two cities have both centralised (citywide) and per barangay (“the smallest of administrative divisions”) material recovery facilities (MRF); these facilities concentrate on biodegradable waste and create charcoal briquettes from water lily—an initiative implemented by a private social development foundation and the Laguna Lake Development Authority (LLDA). What is unique to the City of Santa Rosa is the concept called “Basuranihan (Basura Bayanihan),” which means working together for waste management. This initiative was implemented in different barangays in Santa Rosa, comprising a waste exchange program. Barangay officials purchase recyclables from their constituents using a point system that residents can use to buy basic commodities. This has enhanced the waste recovery efforts of the City of Santa Rosa.

### 3.1.2. Waste Management Issues in Rural Coastal Communities

In the rural communities represented by the municipalities of Atimonan, Alabat, and Perez (Quezon Province), the main materials waste along the coastal area are plastics and coconut husks. The fisherfolk shared that plastic waste and coconut husks would often get caught in their nylon fishing nets. Moreover, the waste found in the lake has a direct impact on the quantity of fish that they have observed, having been reduced significantly over the past years. They stated that it seems as if the fish could not reproduce, and that some of the fish might have been poisoned by the presence of waste. According to the fisherfolk, some types of fish that were previously abundant, such as swordfish and herring, do not appear anymore, which they considered to be a result of this phenomenon. The fisherfolk believe that the reason for the increasing amount of waste is that there are more fisherfolk operating in the area than before.

To dispose of coconut husks, the fisherfolk expressed that burning would be a more convenient way to dispose of them; however, the use of fire to get rid of waste goes against the Clean Air Act. The fisherfolk expressed their belief that the burned coconut husks could be converted into fertiliser. However, composting coconut husks takes a while; hence, it is too inconvenient to make fertiliser in this manner. As a result, the fisherfolk are overwhelmed by the volume of husks—dealing with them would additional work if they were to bury them in the ground.

Every last Saturday of the month, Barangay Angeles conducts the Youth Civic Action Program (YCAP)—Community Clean and Green. This is a barangay-wide cleaning program that usually lasts for two hours. The concept was based on the green revolution of the Marcos era (in the 1970s). In these municipalities the coastal clean-up is a periodic activity. There were times when the municipal government, with the help of community volunteers, would collect around 30 sacks of mixed waste from the coastlines, which would normally consist of non-biodegradable waste—such as diapers, plastic utensils, paper bags, and paper plates from fast food establishments. This is particularly prominent in Atimonan, as it is located near a highway where residents and visitors alike would often throw their food packing waste and personal hygiene waste into the most convenient places, resulting coastal waste pollution.

At the barangay level, community residents claimed that they practiced waste segregation, usually separating biodegradable from non-biodegradable waste. This is the simplest and most effective waste segregation strategy. There are also four eco-aides: individual volunteers who collect waste from households by foot or via bicycles. The four eco-aides who operate in the different zones of the barangay earn an estimated PHP 2000.0 each monthly from the barangay fund. The waste which is collected is sent directly to the Barangay’s MRF. The residual waste—including diapers—is collected by the garbage truck of the municipal government, which has a fixed schedule for garbage collection. For instance, on Wednesdays, biodegradable wastes are collected and are set to be disposed

of at a dumping site. For the rest of the week, non-biodegradable waste is collected. The waste collected from the coastal area is also picked up by the truck and segregated in the barangay's MRF.

In Perez, Quezon, which is another rural coastal municipality, waste segregation has become more prevalent over the recent past. Local government participants recalled that it was only by November 2019 that most residents of the municipality practiced waste segregation. The municipal government has a garbage collection truck that collects solid waste from Monday to Friday in the población, or centre of the coastal town. A project to construct a sanitary landfill that will convert its existing open dumpsite is also on its way, which will eventually dispose of only residual waste when waste segregation becomes more prevalent. The local government of the coastal municipality was able to implement a project that reuses ground plastics that are being transported to a cement factory in Rizal Province. Aside from this, the coastal municipality was able to comply with setting up a MRF in every barangay. This enables them to practice waste segregation and benefit from selling recyclables.

When asked about waste disposal, it was mentioned that some families still dispose of their uncollected waste in the sea. To avoid this practice, the local government put up signage that served as a warning to the local residents that a penalty will be applied to anyone who is caught dumping their waste on the shore or in the sea. According to local government representatives, schools play an important role by actively involving schoolchildren in the implementation of solid waste management. Many notable SWM efforts involve children—including the emphasis on the importance and actual demonstration of waste segregation from the source. The schoolchildren were properly trained on how to dispose of their waste into waste bins, which were then collected by a garbage truck, which eventually ended up at the dumpsite. The LGU participants also mentioned that selling recyclables also takes place, but that it is usually affected by fluctuations in the price of recyclables in the market. Since this is a business that relies on buying and selling, the low prices usually discouraged many local residents from engaging in selling recyclables as part of alternative livelihood activities.

In addition, in the municipality of Alabat, the LGU also conducts coastal clean-ups in selected barangays, during which they are able to collect approximately 100 sacks of solid waste. It was observed that plastics were prevalent during clean-ups. In this town, and aside from plastic waste, they consider coconut husks and other agricultural waste as a major problem. As a result, when agricultural waste is uncollected during coastal clean-ups, it is either buried or burned. It was also noted that every barangay has a MRF which is well compliant with RA 9003. The participants claimed that biodegradable food and kitchen waste are being fed to domestic animals or pets, and other waste is being decomposed near the coconut plantation and converted into fertiliser.

As shown in Table 3, common solid wastes observed in urban coastal areas include water hyacinth—which prevents the movement of boats and negatively affects fishing activities—and common solid wastes in the rural coastal areas include coconut husks and agricultural wastes that are difficult to decompose and to convert as fertilizer.

**Table 3.** Solid waste types observed in urban and rural coastal communities.

Urban Coastal Communities	Rural Coastal Communities
Water hyacinth	Coconut husks
Dead animals	Agricultural wastes
Diapers	Plastic bottles
Styrofoam	Wood
Plastic food containers	Plastic food containers
Cigarette butts	Cigarette butts

### 3.2. On Climate Change

#### 3.2.1. Climate Change Issues in Urban Coastal Communities

Most fisherfolk in urban coastal communities understand climate change as just a shift in weather conditions and patterns. To these individuals, climate change is about not being able to rely on the typical seasons of the year—wherein certain months of the year are regarded as the rainy season and the remaining months as the dry season. These weather patterns can no longer be the basis for fishing or farming as an alternative livelihood. When asked about its direct effects, most fisherfolk claimed that they noticed a difference in the sizes of the fish (apparently, the fish which are being caught are shrinking in size). This sudden change in weather patterns has somehow also contributed to the siltation of the lake and the surrounding rivers. As a result, fisherfolk need to go further into the lake to increase their catch. This has eventually resulted in fisherfolk being forced to engage in alternative means of sustaining a livelihood, other than by fishing.

On the other hand, they also pointed out because of climate change, different species of fish came to life in the bay. In the past, the janitor fish was considered a pest in the urban fisherfolk communities, as they are not intended as staple food. However, due to its huge presence in the Laguna Lake, the fisherfolk were able to come up with an idea of using janitor fish as raw materials for food products. One notable use of janitor fish is for the fish ball, longganisa, and fish sauce, which can also be sold in the market.

#### 3.2.2. Climate Change Issues in Rural Coastal Communities

On the other hand, fisherfolk in the rural coastal municipality of Atimonan have different perspectives on climate change. Apparently, these communities continue to rely on the prevailing weather patterns. For instance, the months of April–August are the time when the weather is more suitable for fishing, when the sea is relatively calm. They also stated that the climate they have experienced over the past years has been almost identical throughout. However, they have claimed to observe changes in terms of natural hazards. In the past, the months of September–December were those of the typhoon season, while those of January–March were the drier months. However, there has been a change in climate whereby the typhoon season is no longer confined to the last quarter of the year, even appearing at the beginning of the year. No one can predict its occurrence anymore; furthermore, these calamities have, in the recent past, become more devastating. This is also true in the case of the coastal town of Perez, where fisherfolk observed climate change causing higher temperatures, which means hotter days and higher sea levels. They have also noticed an increase in the volume of rainwater during the typhoon season, resulting in flooding which reaches their houses. The participants in the study claimed that the coastal town will be submerged by 2035; when asked if they have studied the possibility of evacuating their families elsewhere, they mentioned that they have not thought about it, but if and when the time comes that they have to leave the coastal town, they will relay it to the people.

In Alabat, community residents considered climate change a phenomenon wherein they experienced extreme heat and confusing seasons. For example, the fisherfolk had observed patterns by which the northeast monsoon (*Amihan*) occurs during the months of October–March, and the southwest monsoon (*Habagat*) occurs during the rest of the year. However, the residents of the coastal town, and the fisherfolk in particular, witnessed and experienced the opposite—*Amihan* during *Habagat* months. The fisherfolk cannot directly identify the direct effects of climate change on their fishing activities, although they admitted having lesser catches; hence, they have taken necessary steps (as part of climate change adaptation), such as resorting to alternative sources of income—such as farming and other economic activities. The fisherfolk mentioned that, in order to know whether or not they could push through with their fishing, they would rely on how they feel the weather will develop. They would feel if the winds were stronger, or if the skies would be darker than usual. They also looked out for the stars. Star visibility means that the sea would be calm throughout the following day. This was a signal to go out fishing for

the day. It was noted that the colder weather was more favourable for the fish, and thus it would provide a larger catch for the fisherfolk. The fisherfolk are mainly concerned with illegal fishing activities; in order to address these issues, Alabat has employed sea monitors (Bantay Dagat) and conducts coastal clean-ups. During the FDGs in the municipalities, it was mentioned that the erosion that leads to siltation directly affects the number of fish in the sea, as erosion damages the corals.

### 3.3. On Disaster Risk Reduction

#### 3.3.1. Disaster Issues in Urban Coastal Communities

In urban communities, fisherfolk consider the perennial presence of water lilies (water hyacinth) and typhoons as the main hazards. Water lilies per se are not hazards, but as they flourish between September and December, their huge presence prevents individuals from engaging in fishing activities or limits their movements.

As for the worst typhoons experienced so far, urban fisherfolk considered 1995's Typhoon Rosing (or Typhoon Angela) and 2006's Typhoon Milenyo (Typhoon Xangsane) the worst, as most of their houses were destroyed, fishponds were mangled, and it took a few days before they were able to return the situation to normal.

Fisherfolk in urban areas rely on radio and television to obtain information and early warnings for possible disasters (typhoons, floods, and fires). When they heard that the typhoon was already at the Philippine Area of Responsibility—specifically Bicol (another region)—they would take precautionary measures to protect themselves and get ready, given that they would definitely be affected. They were able to establish this flow of information as an early warning system.

As part of their disaster preparedness, the fisherfolk would place their fishing nets in a safer place so that they would not be destroyed; when warned about a strong typhoon, they would always follow pre-emptive evacuation efforts by the City Disaster Risk Reduction and Management Office (to go to nearby evacuation centres). They mentioned carrying with them go bags containing rice, canned goods, medicine for two days, and very important documents. In the city, disaster preparedness seminars have been conducted throughout the community. A community-based emergency response team composed of 36 members was available to respond. For the part of the barangay, there were supplies and equipment available—such as life vests, radios, speakers, and megaphones. As standard practice, public schools usually serve as evacuation centres together with covered sports complexes and churches. A significant number of families also temporarily stayed with relatives or friends. There is also a military presence felt throughout whenever a disaster strikes—both for search and rescue and crowd management.

It is interesting to note that cities have implemented programs such as “Cash for work” programs, where the volunteers would be paid for a half day's work to clean up the coast. It was also noted that in 2013–2014, “Food for work” was implemented after a typhoon, which gave out food (rice and canned goods worth PHP 200.00) in exchange for their cleaning services after the disaster.

#### 3.3.2. Disaster Issues in Rural Coastal Communities

In the municipality of Atimonan, residents had witnessed the worst disasters, such as Typhoon Glenda (Typhoon Rammasun) in 2014 and Typhoon Rosing (Typhoon Angela) in 1995, which greatly affected the province of Quezon. During these typhoons, individuals could not return to economic activities—including fishing—for two days. As soon as the sea calmed, fisherfolk were then ready to start fishing once more.

During evacuations, women and children are usually assisted by the barangay emergency response team. In most cases, the fathers (or adult male members of the family) stay at home, even if it is risky. This is to avoid falling victim to theft and looting. Inside the evacuation centres, the local government usually provides clothes, food, blankets, and mats. The barangay also has an emergency vehicle provided by the local government of Atimonan.

To inform the community residents and people of the impending disaster, announcements are made on the television, radio, and even by cell phones via the national weather agency or the national disaster risk reduction council. Megaphones are also utilized to announce if there is a need for evacuation. Often, house-to-house announcements are made for early warning notices. During data gathering, it was found that financial assistance was provided by the government. The fisherfolk and women received free insurance, granted by the Philippine Crop Insurance Corporation (PCIC), whereby beneficiaries have to fill-out a form and pay a registration fee, or PHP 200.00 per year, for their fishing boats. Usually, for a totally damaged fishing boat, assistance can reach up to PHP 36,000.00.

In the municipality of Perez, on the other hand, whenever there is a community (barangay) assembly, a reminder is always given to attend the disaster drill and exercise and monitor TV and radio programs to receive information regarding things that need to be done when a disaster strikes. Additionally, the barangay in the coastal town formed a “kabalikat civicom” which will be accompanied by a rescue vehicle. An information dissemination mechanism is also in place to broadcast instructions to residents; however, challenges arise when it comes to disseminating information to four barangays (since the signal seems to be very weak in those places). Community residents from these four barangays were, thus, equipped with emergency kits. Supplies come from joint efforts made by the barangay and the municipality. Potable water during a disaster is supplied by a barangay.

The representatives of the coastal town of Alabat had more typhoon experienced beyond that of Typhoon Rosing and Typhoon Glenda, as they also experienced Typhoon Ondoy (Typhoon Ketsana) in 2009, and Typhoon Yoyong (Typhoon Nanmadol) in 2004. During these incidents, a national law guiding the local government units was put in place (Presidential Decree—PD 1566) until a new law was drafted (known as the Republic Act 10,121 of 2010, Strengthening the Philippine Disaster Risk Reduction and Management System), which paved the way for the improvement of all facets of DRRM in the country.

Our findings show that the livelihood of fisherfolk was subject to a mixture of risk factors that we targeted in this study. It was found that fisherfolk who face decreases in fish hauls have limited opportunities for alternative jobs that they can engage in due to their limited skills. Apparently, there was no specific alternative livelihood that could be identified; LGUs do not have plans, programs, or projects that would build the needed capacity for fisherfolk to be able to work when fishing is not a feasible option.

### 3.4. Key Observations on Interactions among CCA, DRR, and SWM

Based on the above findings, the paper gives information on the interactions among climate change, disasters, and solid waste. The manner in which the interactions took place among them is as follows.

#### 3.4.1. Compound Risks, Where Multiple Factors Amplify One Another

First, we observed the compound risks facing the livelihood of fisherfolk. Fishing hauls have declined due to multiple factors, including fisherfolk’s habits, waste generated by residents’ dumping, typhoons, and climate change-related phenomena (such as changes in weather patterns and erosion). Respondents claimed that there is a continued increase in the kind and volume of solid waste being dumped into the bodies of water, which directly affects fishing activities as a source of livelihood. There are cases where one factor amplifies the impact of another; climate change has confused fisherfolk’s anticipation of typhoons. We do note, however, that there was a positive side to the effects resulting from climate change (such as the introduction of fish species that were previously unavailable in the suburbs, and which are now new source of income). There was also a testimony that garbage blocked waterways and caused flooding. When a typhoon occurred in the coastal areas of both rural and urban fishing communities, more waste was generated—such as coconut husks (rural) and water hyacinth (urban), and a mix of domestic waste of both kinds.

### 3.4.2. Unintended Impacts of Countermeasures for One Issue on Another

Second, we found that countermeasures for climate change, disasters, and solid waste cut both ways. Some cases were identified in which measures aimed at preventing the influx of trash have led to disasters and have negatively impacted fisheries. The participants from the urban communities described the situation as one-sided. For instance, the local government has addressed the garbage concern by closing the floodway and preventing trash from entering the bay. This might have prevented the trash from entering the premises, but it also prevented seawater from entering—thereby causing a proliferation of waterlilies.

### 3.4.3. Gaps in the Perception of Cross-Sectorality

Third, our study also reveals that these interactions do not have a clear policy implementation from the national to the regional and to the local levels of governance. All the LGU representatives in all of the study areas, disaster risk management, climate change, and solid waste management, have three different concerns guided by three distinct national laws. While there was both a pronouncement and initiatives from the National Government to link DRR with CCA, there are no concrete efforts that could yet be seen in local communities. This is true in the case of waste management, as this is being implemented as an independent program and has yet to be linked to DRR and CCA. The different LGU representatives are aware of the national government's efforts to link DRR with CCA. However, this is not realised at the local level, as there is a lack of specific guidance on how to go about it. In the meantime, the different LGUs in the study area implement three different programs in isolation from each other. The DRRM council has its own meeting and local SWM board or council, but there is no distinct committee or council for climate change. CCA is apparently covered by the SWM board, and CC mitigation concerns are handled by the DRRM council. This has resulted in poor governance in terms of interactions among the three areas of concern.

Furthermore, we found that within the Philippines, fisherfolk from both urban and rural communities, and the different stakeholders, have not seen nor realized the importance of link between DRR and CCA, nor their impacts on waste management. Some of the interesting revelations made by the fisherfolk and the LGU stakeholders confirmed some minimal understanding of the concept of climate change and its link to DRR, whose purview is situated within the context of disaster response.

## 4. Discussion

Over the past decade, the question of what factors determine resilience and vulnerability for complex interactions between humans and environmental systems has been a central concern [34]. Therefore, local policy and actions often address issues in silos, which results in failure to exploit the full capacity of communities toward coastal adaptation. Creating spaces for interaction between different policy-implementation channels (LGUs in the case of the Philippines) which share overlapping concerns might help communities fulfil such a gap and harmonise three distinct but interconnected policies. For complex problems, there are limitations and challenges in linking knowledge to implementation [35]. As such, the first significant step toward harmonisation is to improve the level of knowledge of complex problems and the limited consensus concerning the questions to be addressed by policies or overarching goals. For example, raising awareness of a broader work context (through interdisciplinary professional training) fosters institutional collaboration [36,37]. Our interviews with government officers in the Philippines revealed that, on a local scale, it is often the case that a single administrative officer is in charge of multiple departments within an LGU due to a lack of human resources and budget limitations. This can be seen not only as a challenge in terms of securing sufficient human resources but as a potential entry point for breaking silos and achieving a harmonised approach to issues within and across communities.

From an implementation perspective, we also found that there is a possibility in the communities themselves to create more synergies between each policy measure. Volunteer-based activities were introduced in each study for the purpose of coastal clean-ups. Furthermore, there are some existing practices that act as solutions to cross-cutting issues: In both areas, volunteer-based activities, such as regular clean-up efforts and a house-to-house collection of refuse were observed. In addition, the “Cash for work” and “Food for work” programs, along with the coastal clean-up activities after a disaster, were found to be supportive in some ways. Such community networks and practices could serve as potential resources for a community that can also be applied to other problems. We propose utilising such voluntary platforms and community networks to fill in some existing gaps in a particular issue—such as information dissemination at a barangay level in the case of disasters and emergencies [38]. It was also observed that social workers in communities can provide significant leadership in the field of environmental studies and concluded that the complexity of prevailing issues requires practical responses that are multifaceted and flexible. By combining existing knowledge, skills, and resources, communities can strengthen their capacities to understand the underlying nature of complex problems and develop effective and locally-feasible solutions to address them [39]. The key questions that can be drawn from this study include: Even if the issue is individual, if it leads to the same consequences (such as a loss of income for fisherfolk), which jurisdiction will provide support? Why is there no policy coordination to prevent instances where measures to address one issue contribute to another? There is a need to create a local platform that would allow more meaningful interactions of the three areas of concern that are dichotomized at the national level of implementation. Conversely, measures for one issue may be beneficial for the two others—how can such measures be mainstreamed at the local level? If volunteers and other activities have already been established to address one issue, could they be employed for others?

## 5. Conclusions

This study aims to pave the way to understanding how three specific issues—climate change, disasters, and solid waste—are linked to one another in the context of creating a sustainable and resilient coastal community. We conducted qualitative research across three municipalities and two cities (in urban and rural regions) with stakeholders in the communities (including government officials, school officials, and civil society organizations, among others) and fisherfolk as key informants. Our initial research questions concerned the identification of linkages between climate change, disasters, and waste issues that influence vulnerability in coastal communities, and whether there are synergistic or offsetting effects or measures taken by local governments to address each problem. In this regard, qualitative research provided insights. The study identified several specific instances of interaction between the three issues in each of the study sites, and it was found that awareness of these combined impacts was low among local government and community members, particularly the fisherfolk. We also identified that, while measures are being taken to deal with each individual issue appropriately, they are being implemented in a fragmented manner. One possible harmful consequence of such a siloed approach is that those who struggle with multi-causal damages and losses often lack a safety net (due to complex and diffused responsibilities). The absence of organizational bodies responsible for the losses caused by multiple factors is likely to result in a policy vacuum in coastal adaptations.

A limitation of this study is that we provide minimal methodological implications toward the integrated approaches for our targeted issues. We put a focus on offering initial observations of communities’ perceptions of interactions among them. Thus, future research requires deep-dive analysis of the obstacles and opportunities for further reflection on more integrated coastal community resilience management which is able to harmonise CCA, DRR, and SWM.

In conclusion, to go a step further toward enhancing coastal adaptive capacity in response climate change and natural disasters, integrating solid waste management in policy development and actions is worthwhile to consider. Communities in our case study have already experienced but are not fully aware of the interplays of climate change, natural hazards, and waste problems, but they have the potential for generating synergies between all policy measures. Further exploring such policy spaces and integrated approaches would be crucial step, and our study serves as a window to an understanding of these processes.

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**Institutional Review Board Statement:** Ethical review and approval were waived for this study, due to spending more time to coordinate with the Local Government Units due to unexpected external factors. LGU Officials were busy with relief operations of two devastating typhoons between December 2019 and January 2020, while there was an increasing clamor for COVID-19, which forced the research team has to observe their preferred schedule. Instead, we had carried out the study properly and according to ethical practices -we informed our respondents about the study; asked for their consent; anonymized their participation; and told them that their self-reports will be held strictly confidential.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author, N.Y. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

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